Ekonomická fakulta
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Jihočeská univerzita v Českých Budějovicích
University of South Bohemia in České Budějovice

Geographic Information Systems 1
Lecture 9: Spatial Data Analysis

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Spatial Analysis

- **answer questions, support decisions, and reveal patterns**

- all of the transformations, manipulations, and methods
- Data ----> Information ---> Understanding
- "a set of methods whose results change when the locations of the objects being analyzed change"

Which is Spatial Analysis?

- **calculating the average income for a group of people?**
- **calculating the center of the Czech Republic population?**

Types of Spatial Analysis

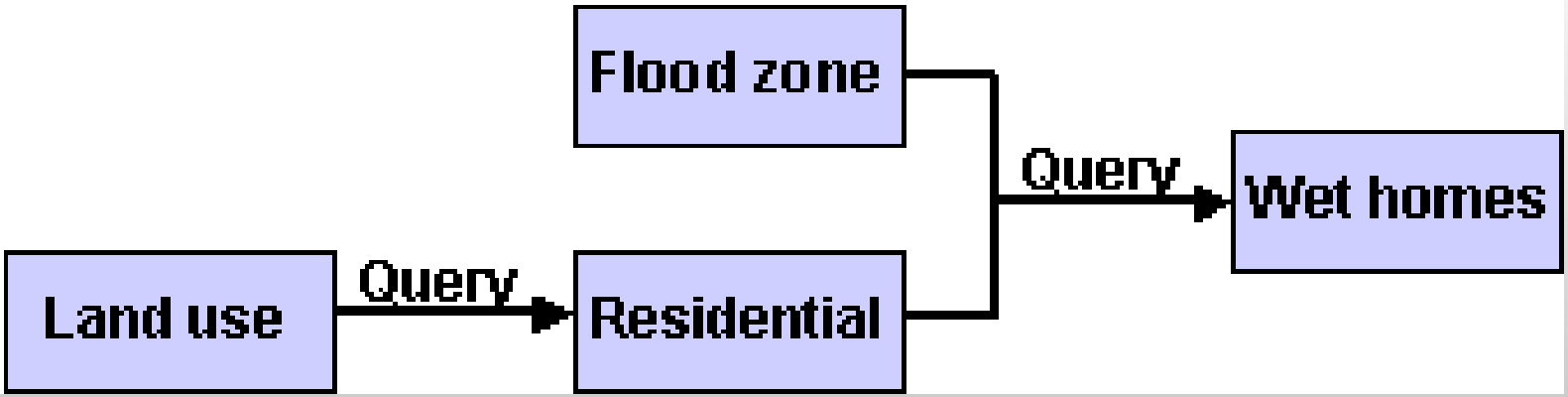
- *Queries and reasoning*
- *Measurements*
  - Aspects of geographic data, length, area, etc.
- *Transformations*
  - New data, raster to vector, geometric rules
- *Descriptive summaries*
  - Essence of data in 1 or 2 parameters
- *Optimization* **- ideal locations, routes**
- *Hypothesis testing* **- sample to entire pop.**

GIS Analysis Model (flowchart)

Residential areas in flood zone

BUT

need spatial analysis to pinpoint locations



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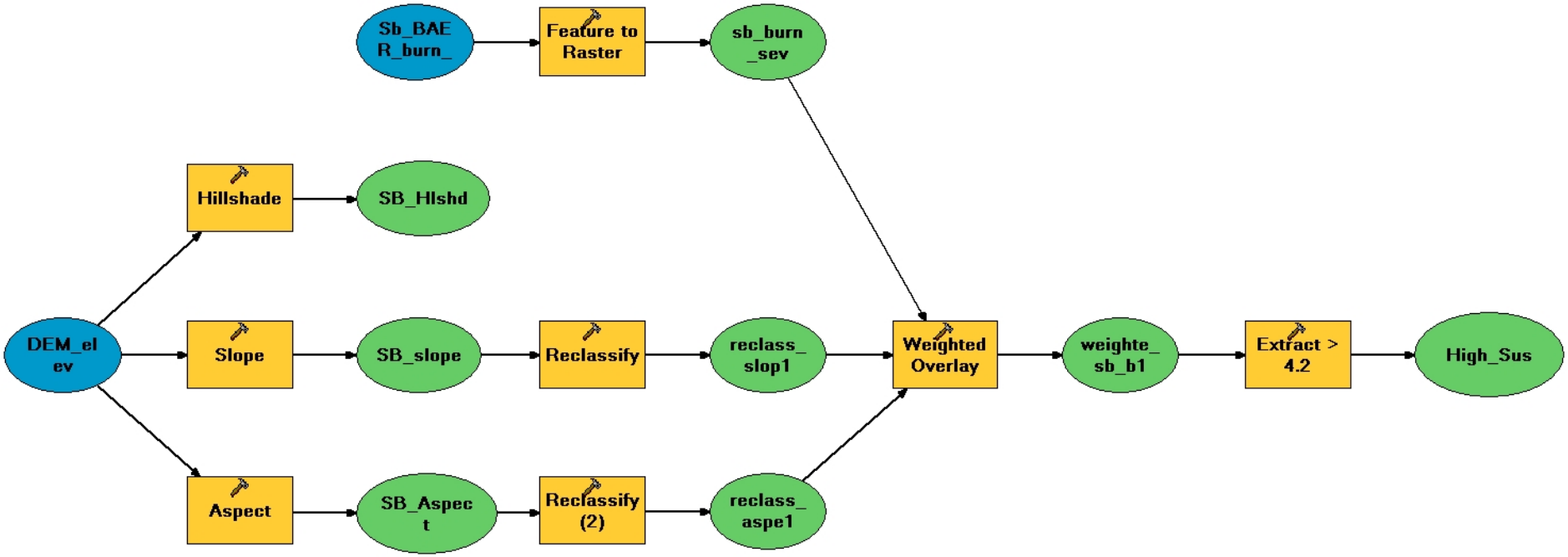
GIS Lanslide Susceptibility Model in ArcGIS Model Builder



2 Analysis Examples from ArcGIS

- **Interpolation** - soil samples on a farm [transformation]

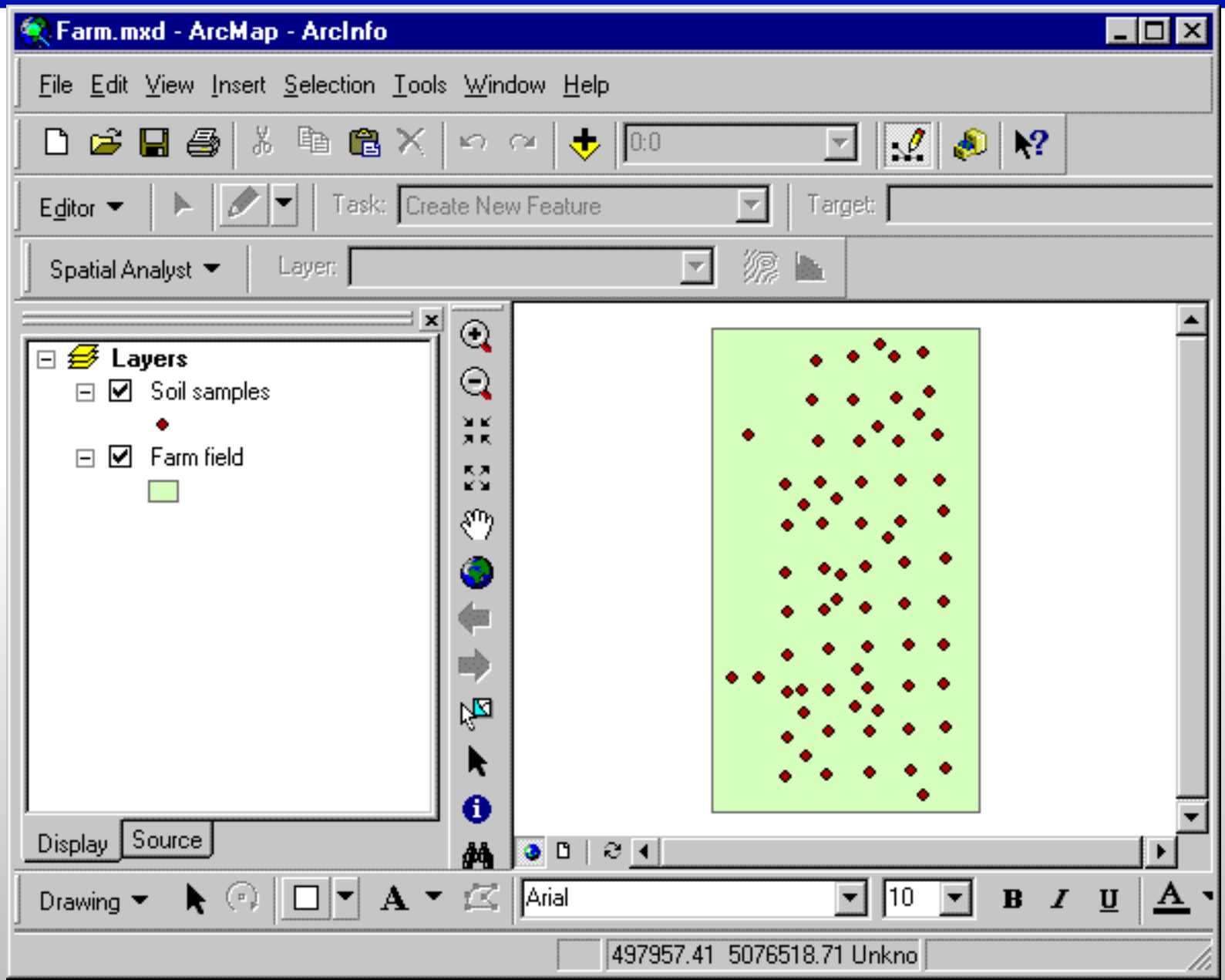
- **Location Analysis** - coffee shops & customers [optimization]

"a set of methods whose results change when the locations of the objects being analyzed change"

- **Interpolation** - soil samples on a farm

- **Location Analysis** - coffee shops & customers

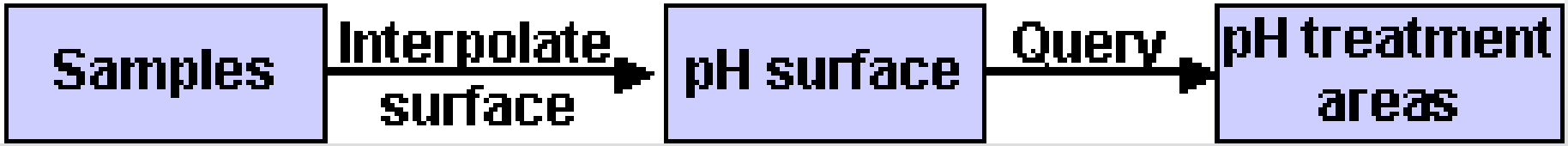
Soil Samples of Farm Area w/ Interpolation



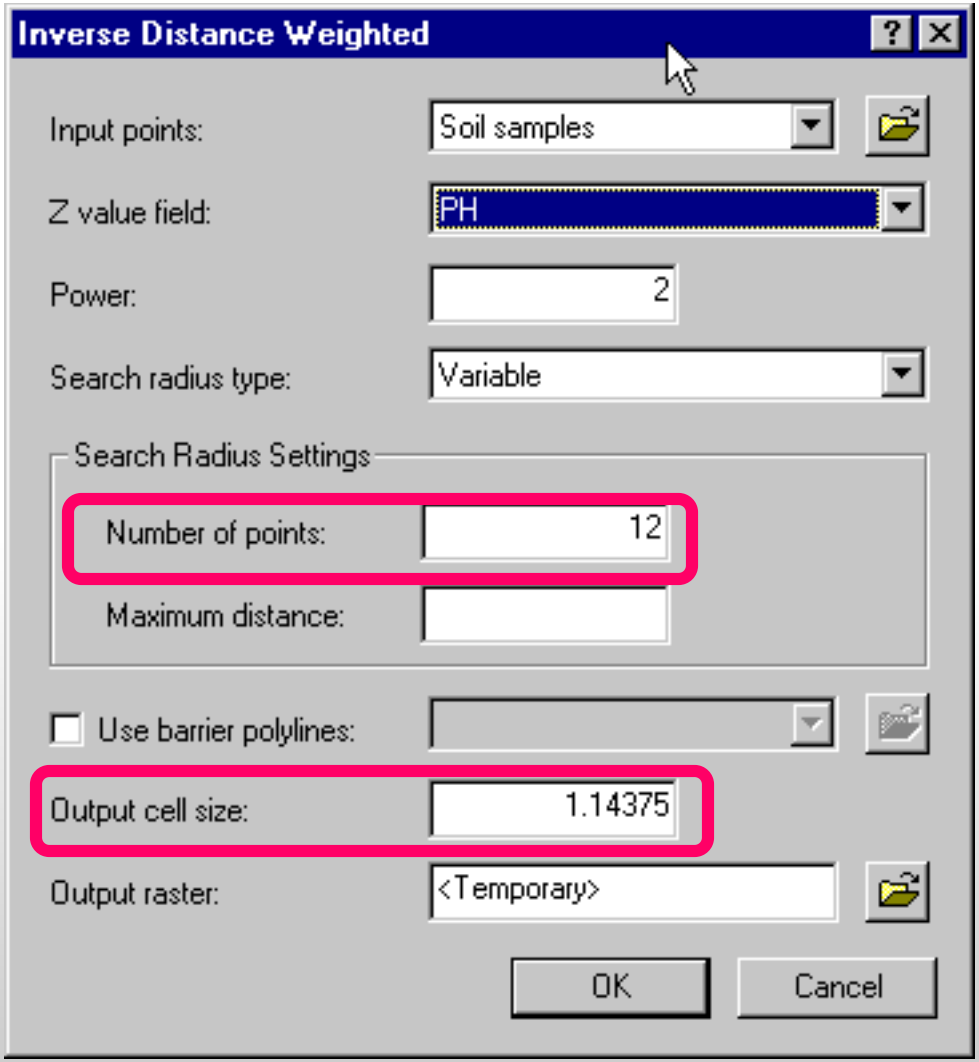
Interpolate samples, then query to find pH > 7

Farmer needs to treat these areas w/ammonium sulfate

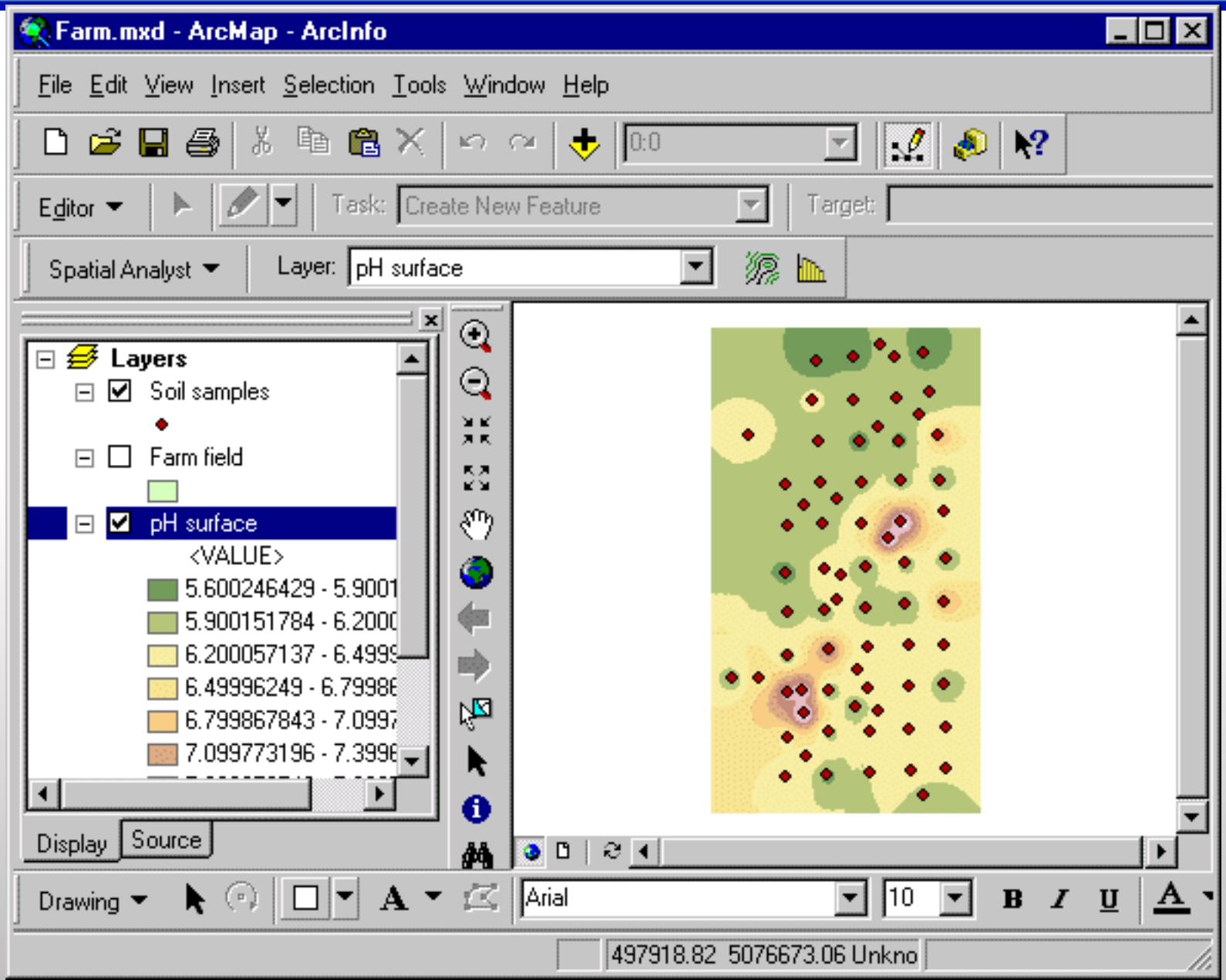
GIS Analysis Model



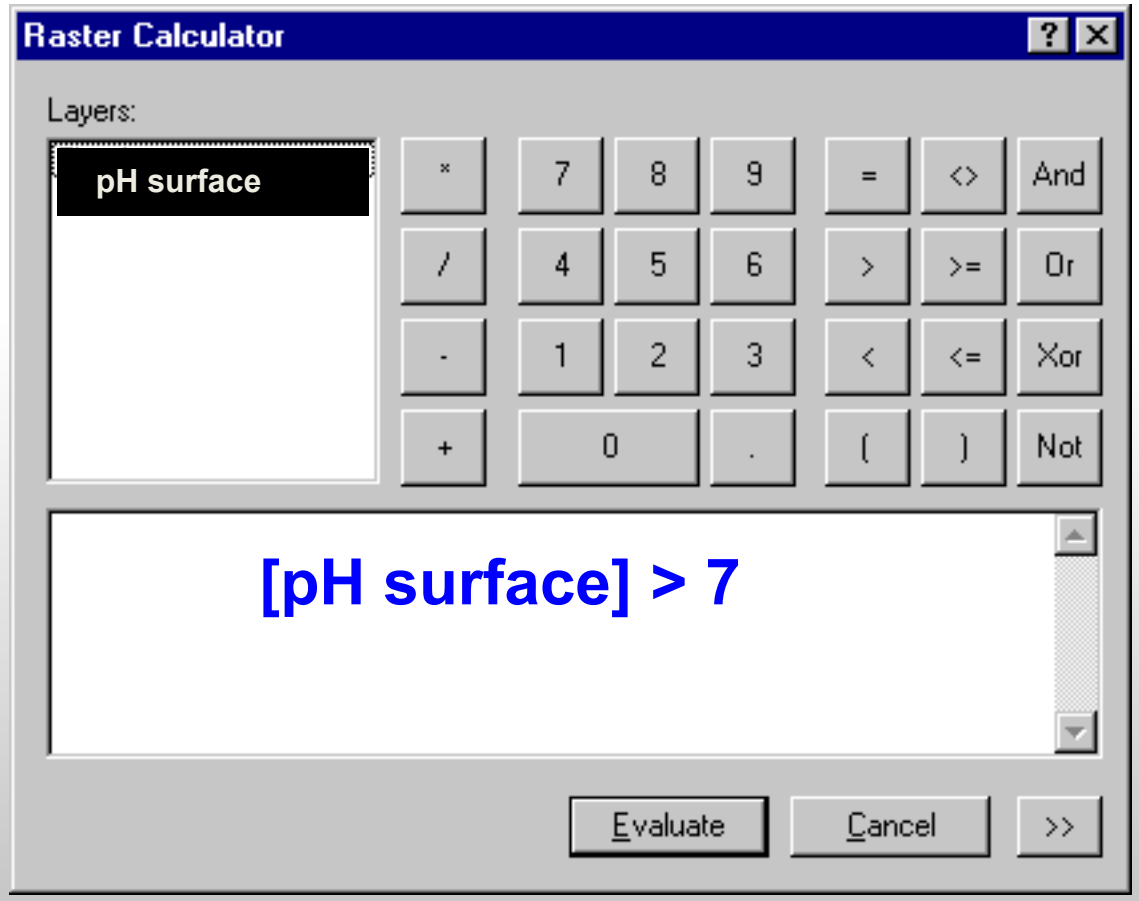
Choose Interpolation Parameters



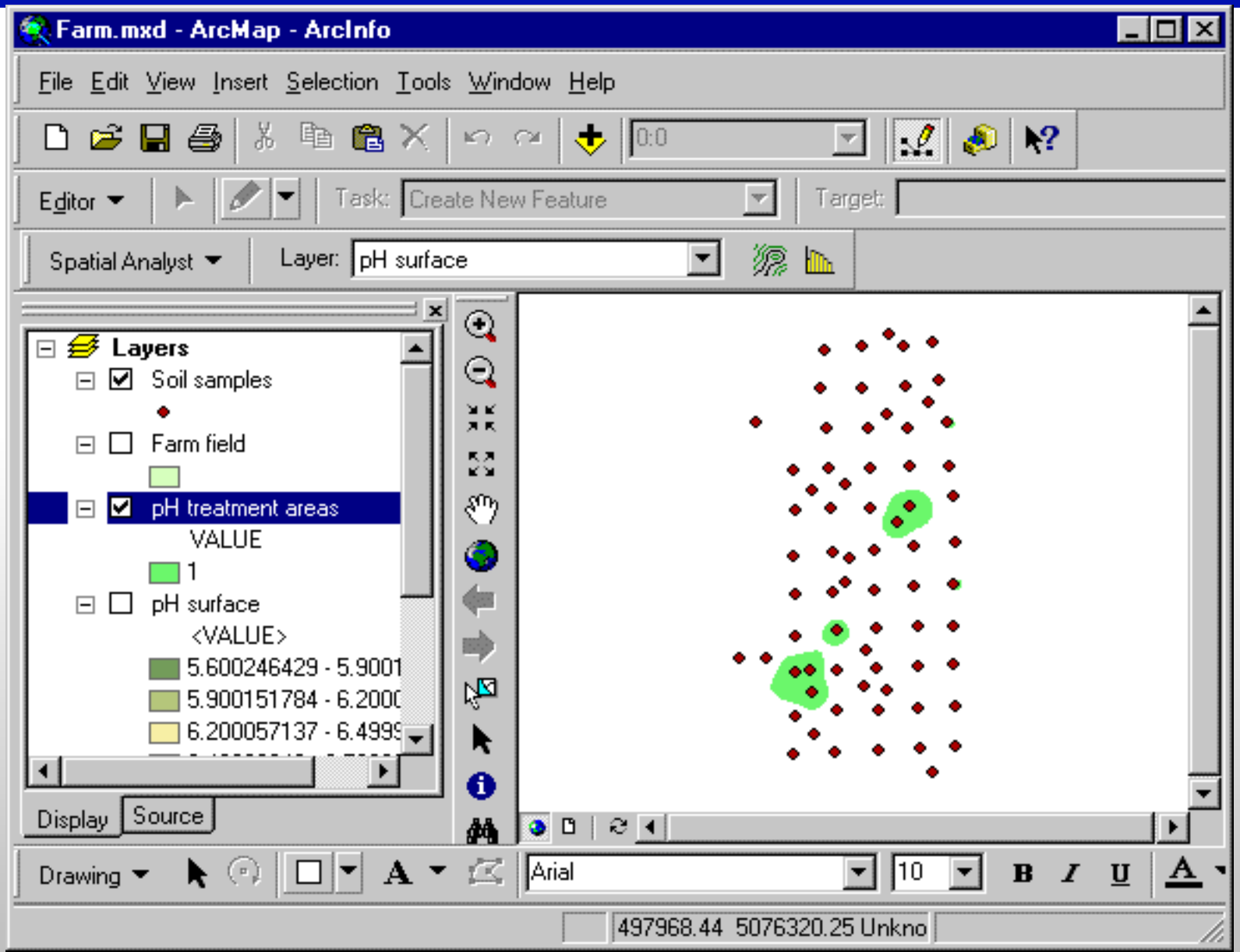
IDW Interpolation



Instead of hillshade, use raster calculator



Result: areas that farmer should treat w/ammonium sulfate to lower the pH to 7 so that soil is balanced



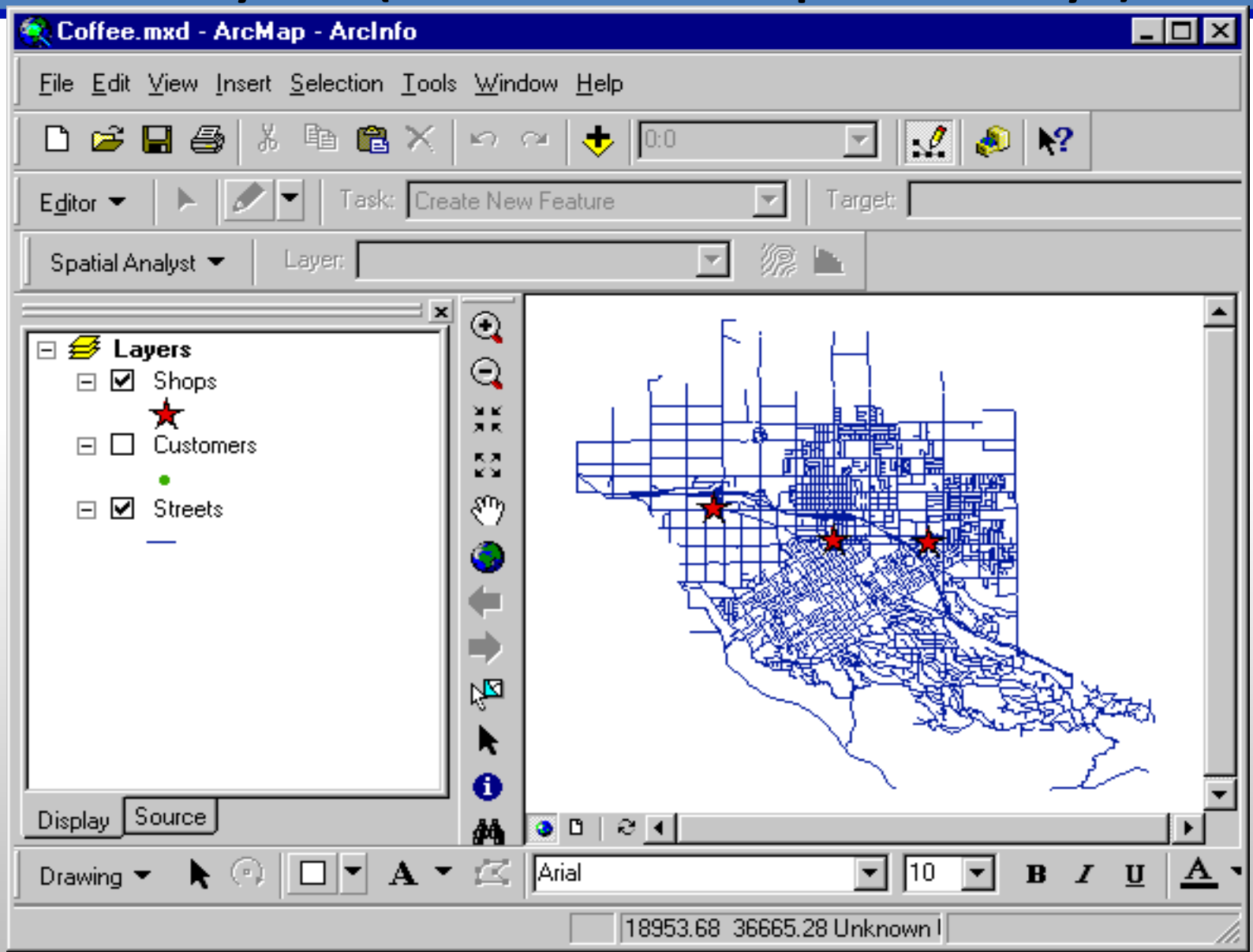
The Farm

- Size = ~5.35 acres (233,046 sq ft. or 21,650 sq m)
- Combined size of new treatment areas = ~0.145 acres (6,338 sq ft or 588 sq m)
- Ammonium sulfate @ $50.00 per acre
  - Treat whole field - $267.50
  - Treat only where needed - $7.25
- Crop yield and treatment maps over time

"a set of methods whose results change when the locations of the objects being analyzed change"

- **Interpolation** - soil samples on a farm
- **Location Analysis** - coffee shops & customers

Best location for new Beanery w/ location analysis (distance & proxmity)



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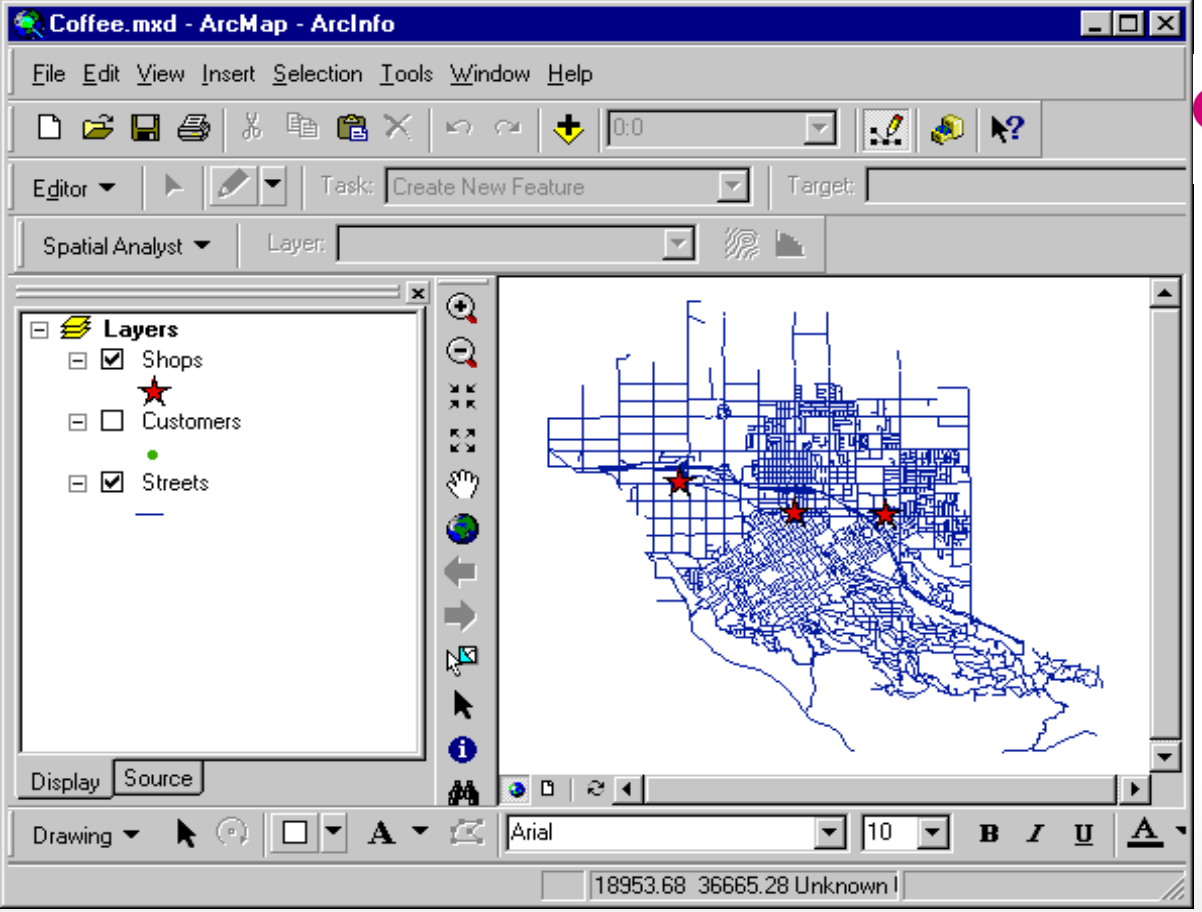
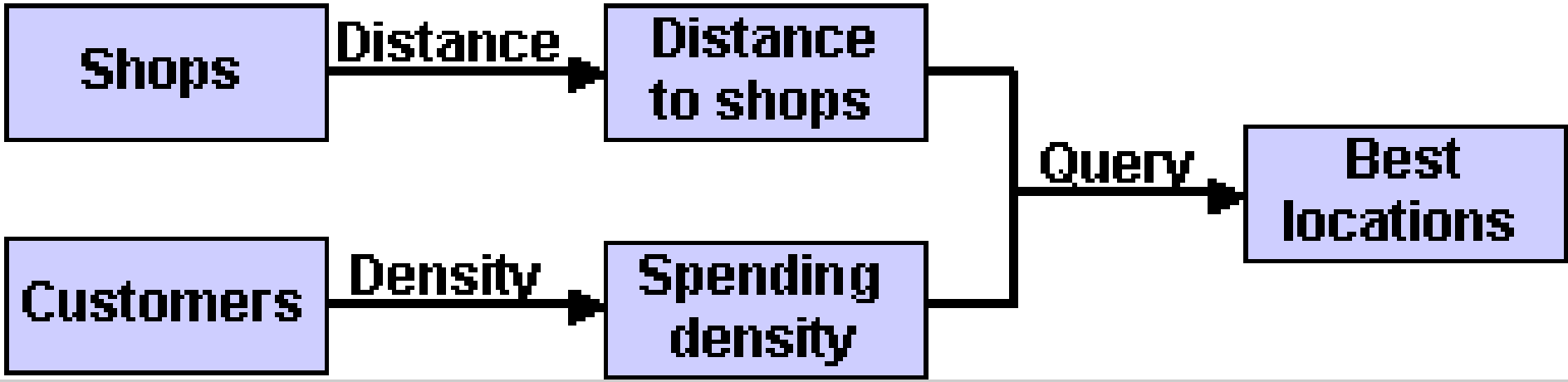
Marketing questions



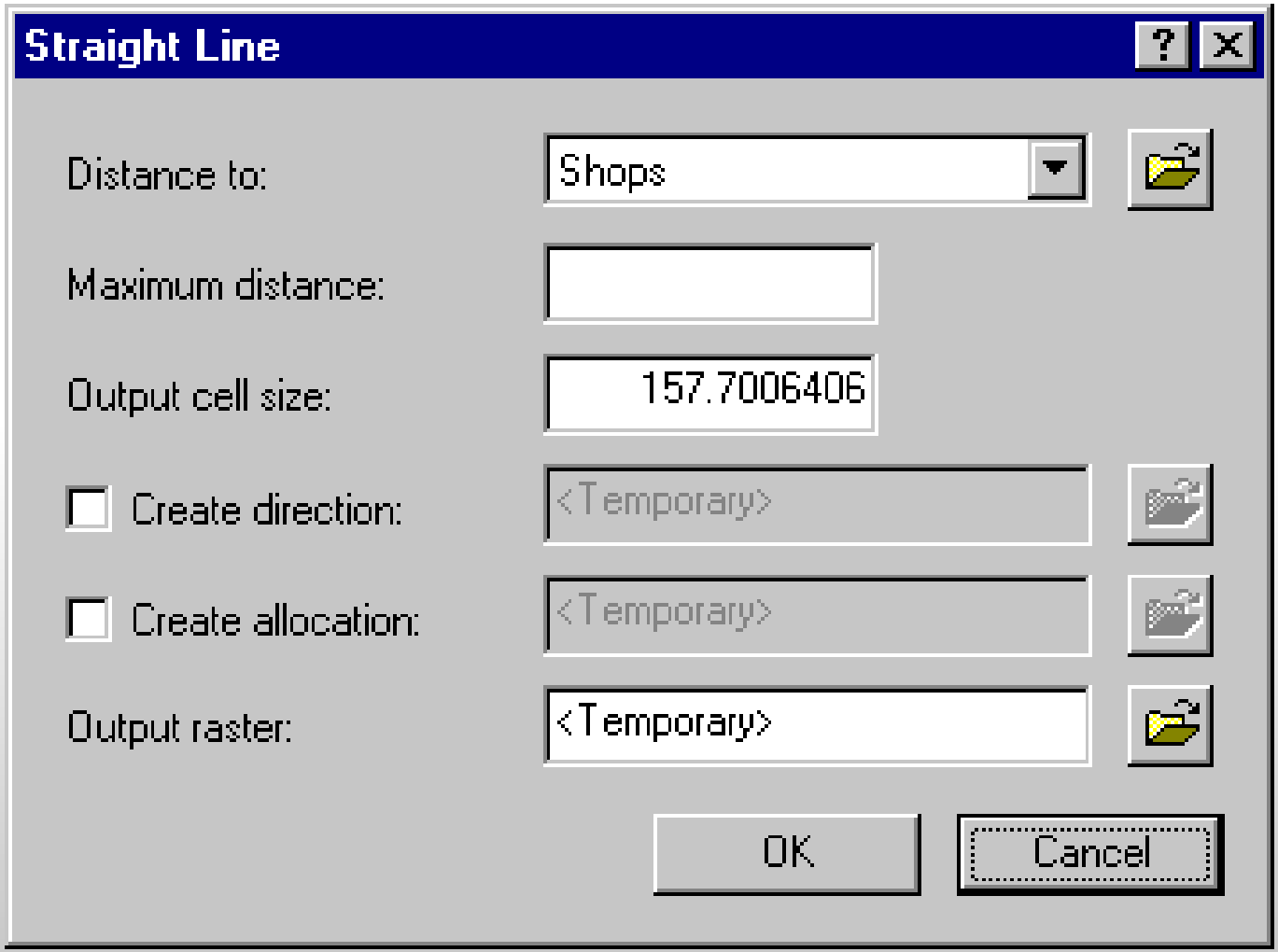
- **Too close to existing shops?**
- **Similar characteristics to existing locations?**
- **Where are the competitors?**
- **Where are the customers?**
- **Where are the customers that are spending the most money?**

Shops w/in 1 mile will compete for customers
Potential shops > 1 mile away

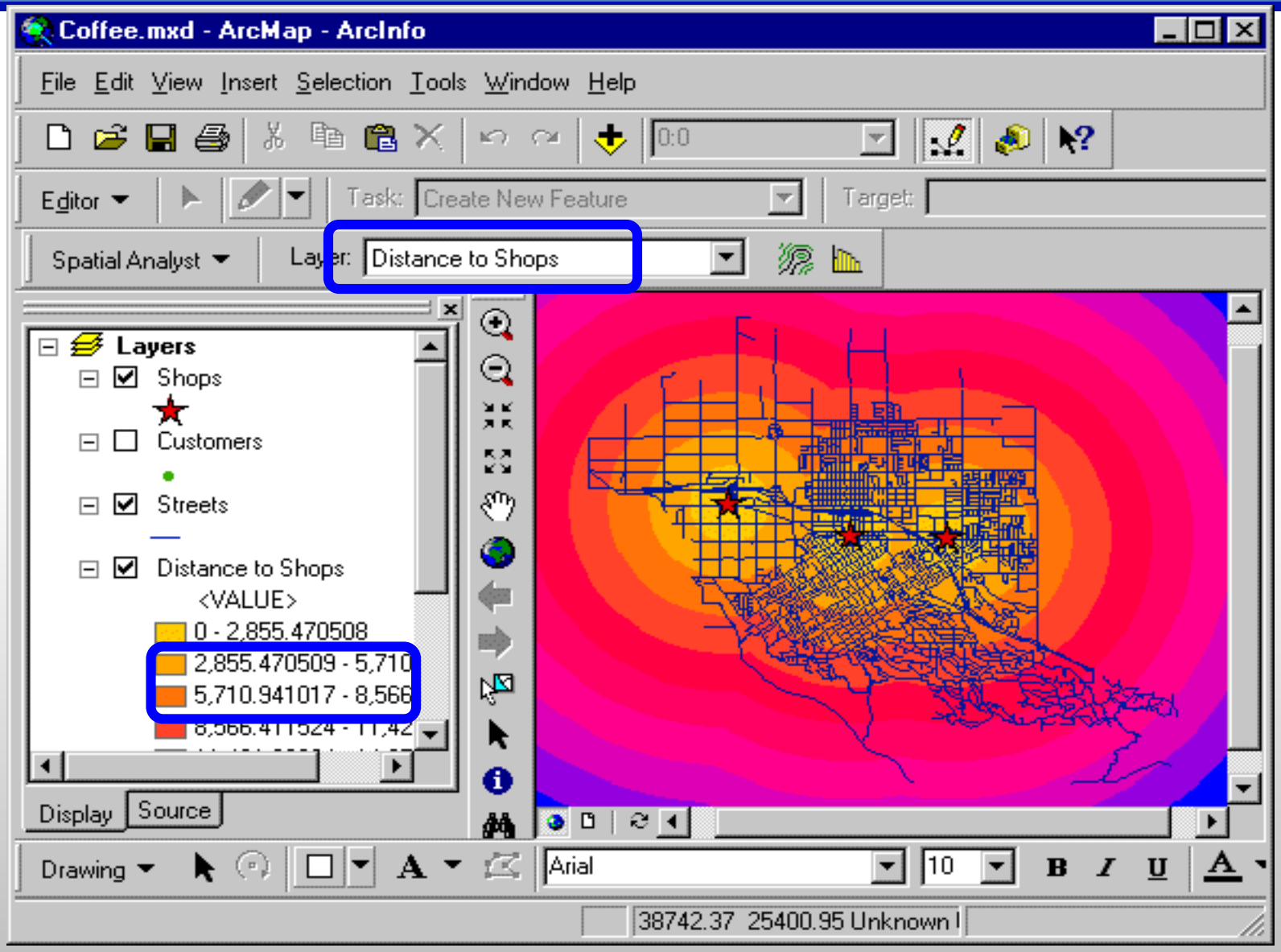
GIS Analysis Model



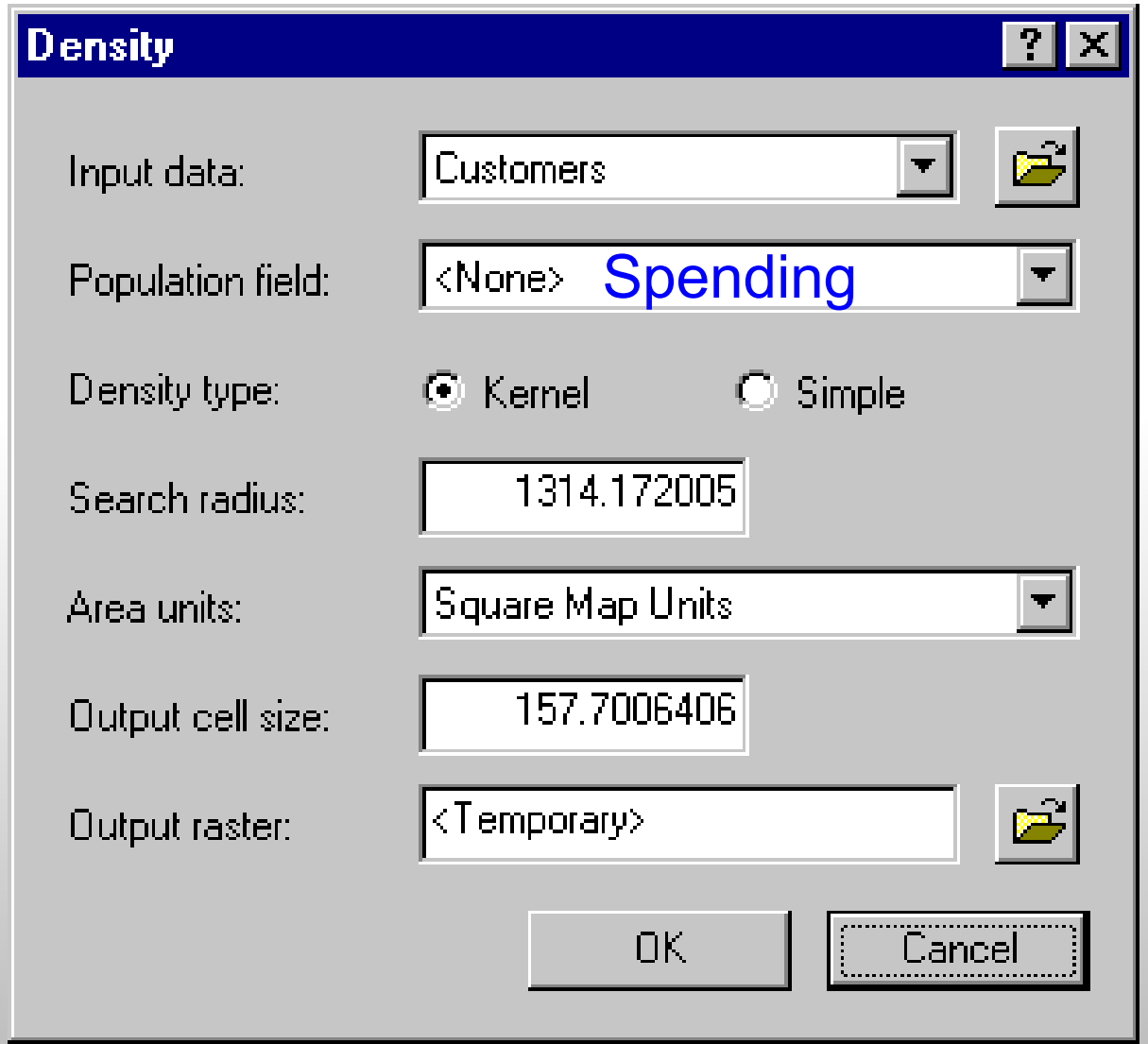
Straight line distance function



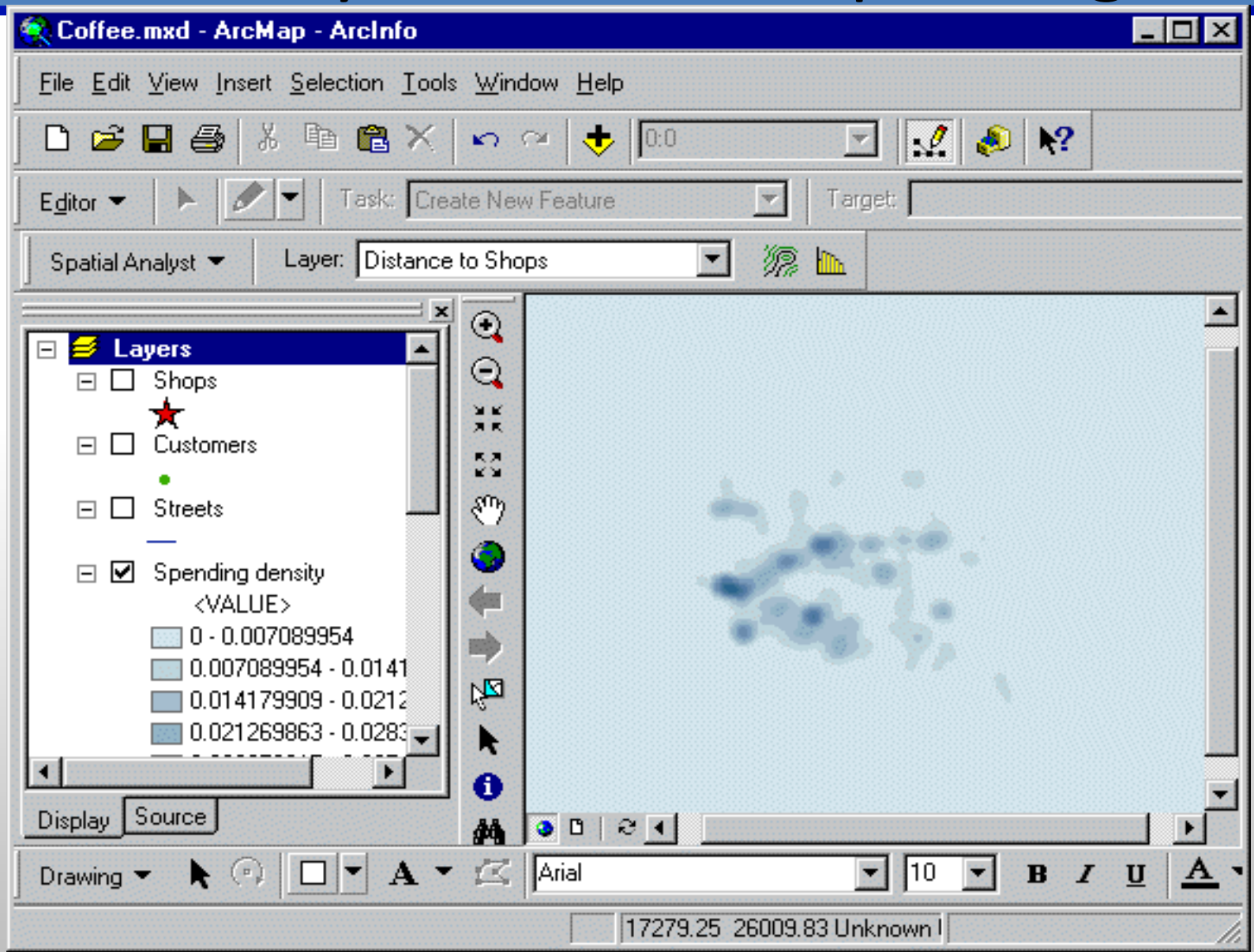
Result: yellow/orange = close to shops
purple/blue = farther away



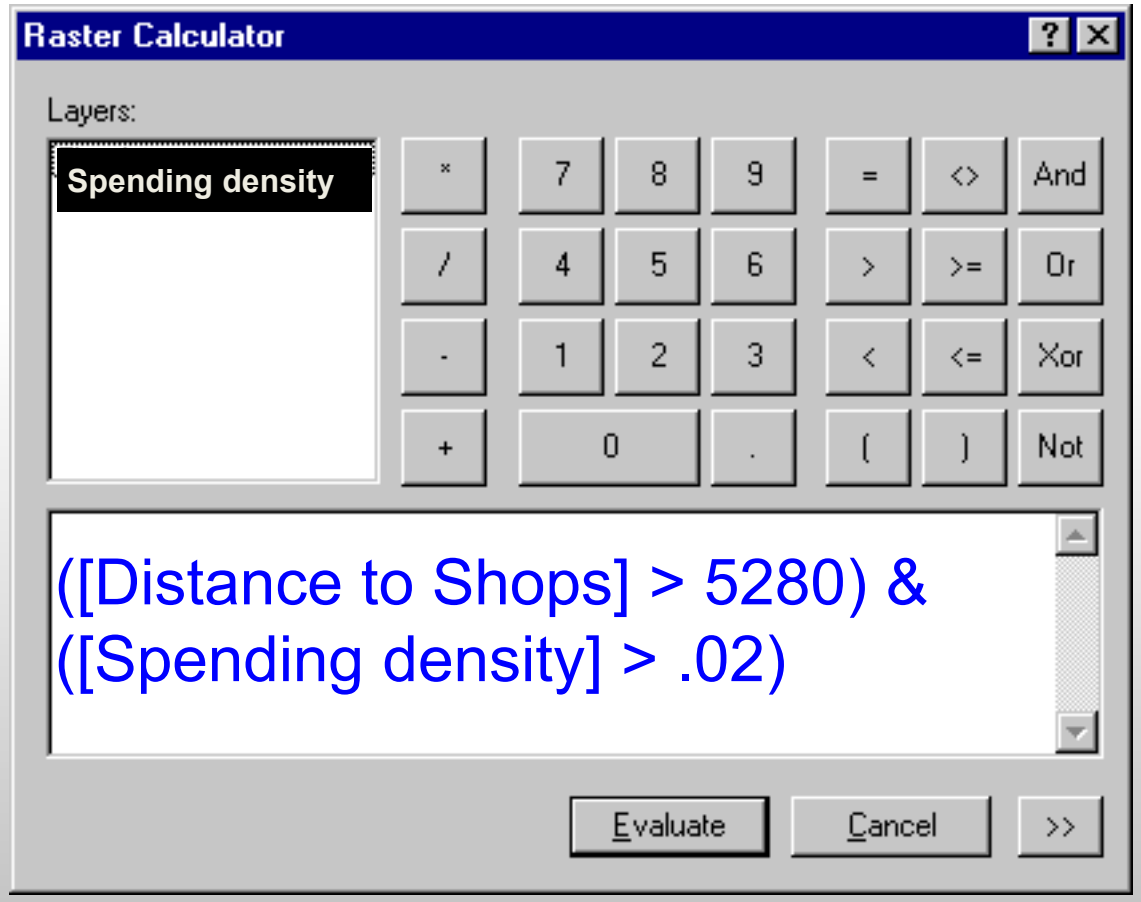
Density Function, Customer Spending



Result: Dark blues are greatest density of customer spending

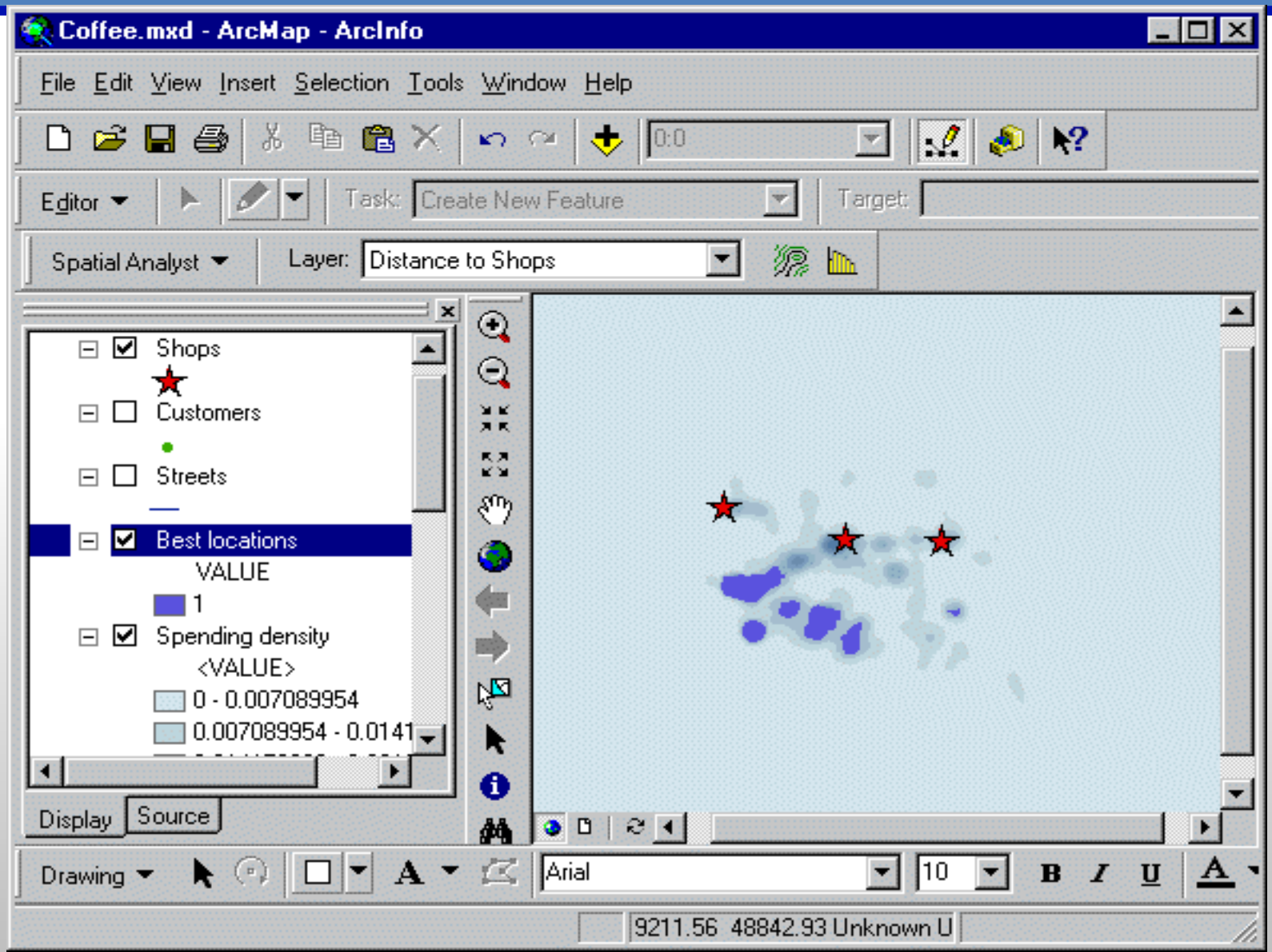


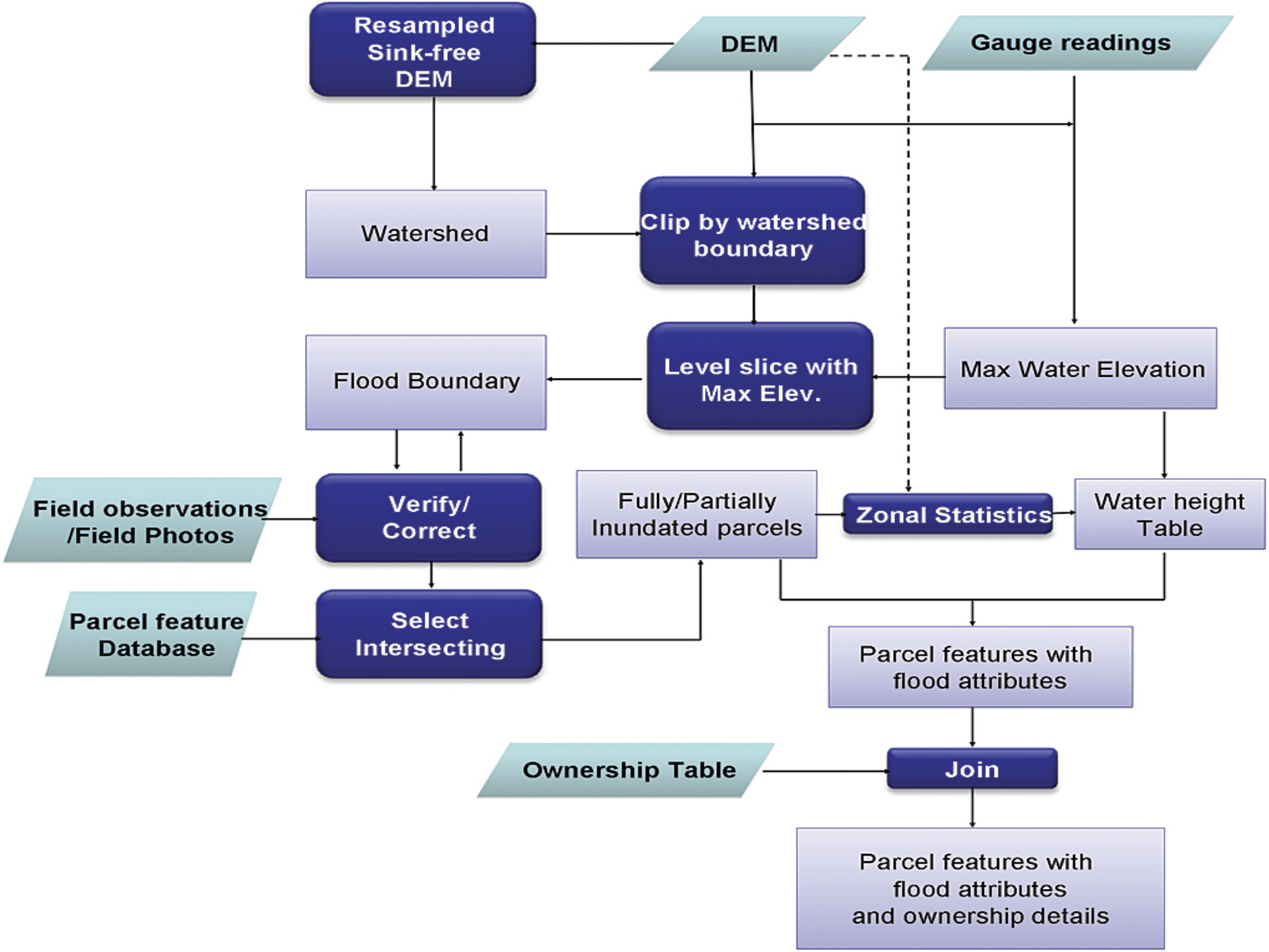
Find areas 1 mile from an existing shop that are also in a high spending density customer area



Result: Best locations for a new Beanery

w/ proximity to an interstate highway, zoning concerns, income levels, population density, age, etc.




Resampled Sink-free DEM
DEM
Gauge readings
Watershed
Clip by watershed boundary
Flood Boundary
Level slice with Max Elev.
Max Water Elevation
Field observations /Field Photos
Verify/ Correct
Fully/Partially Inundated parcels
Zonal Statistics
Water height Table
Parcel feature Database
Select Intersecting
Parcel features with flood attributes
Ownership Table
Join
Parcel features with flood attributes and ownership details

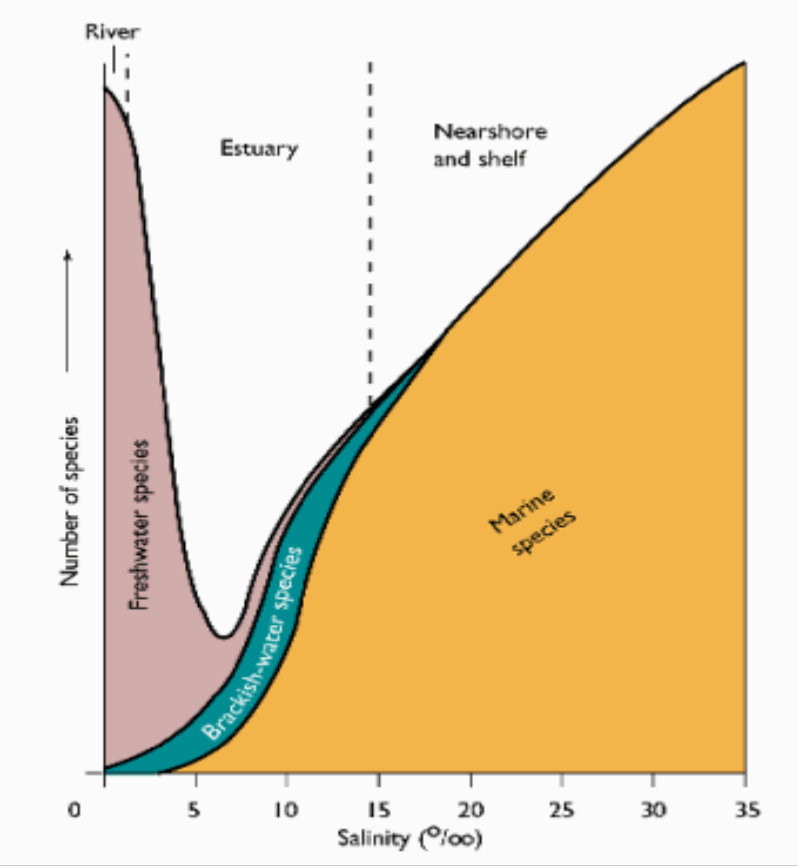
Uncertainty in the Conception, Measurement, and Representation of Geographic Phenomena

- Previous examples assumed it didn't exist
- Conception of Geographic Phenomena
- Spatial Uncertainty - objects do NOT have a discrete, well-defined extent
  - Wetlands or soil boundary?
  - Oil spill? pollutants or damage?
  - Attributes - human interp. may differ

Uncertainty in Conception

- Vagueness - criteria to define an object not clear
  - What constitutes a wetland?
  - An oak woodland means how many oaks?
  - Seafloor ages/habitats
  - What does a grade of “A” really mean??

Uncertainty in Conception

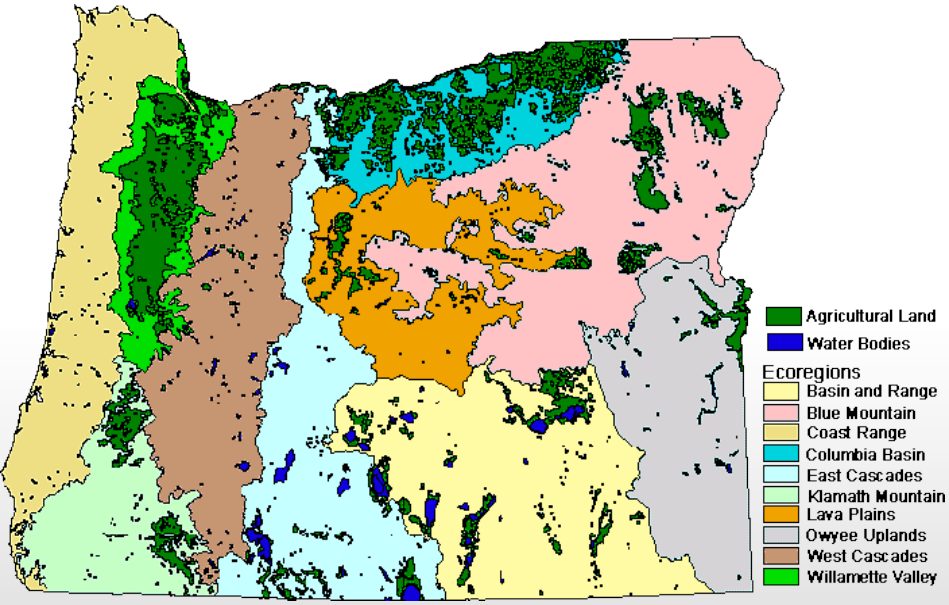


Ambiguity - y used for x when x is missing

- Direct indicators: salinity (x) or species (y)
- Indirect more ambiguous
- Wetlands (y) of species diversity (x)??

Figure courtesy of Jay Austin, Ctr. For Coastal Physical Oceanography, Old Dominion U.

Uncertainty in Conception

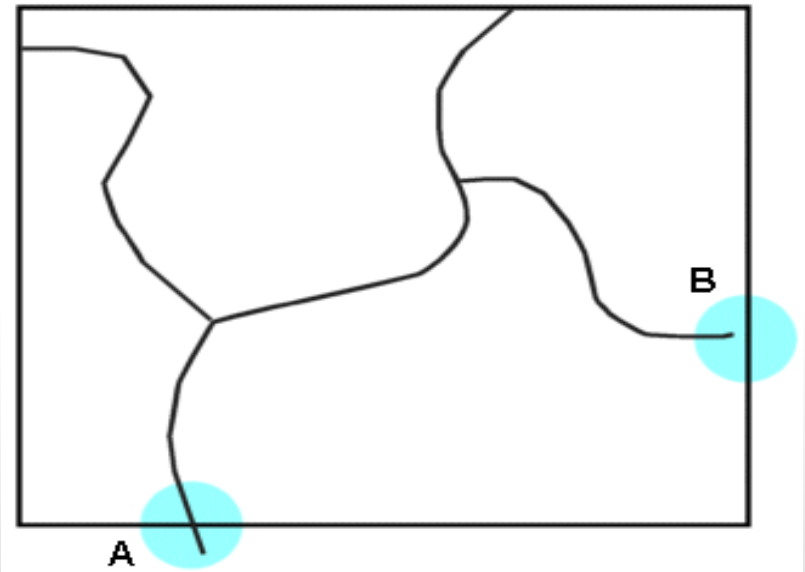


- Regionalization problems
- What combination of characteristics defines a zone?
- Weighting for composites?
- Size threshold for zone?
- Fuzzy vs. sharp

Uncertainty in Measurement

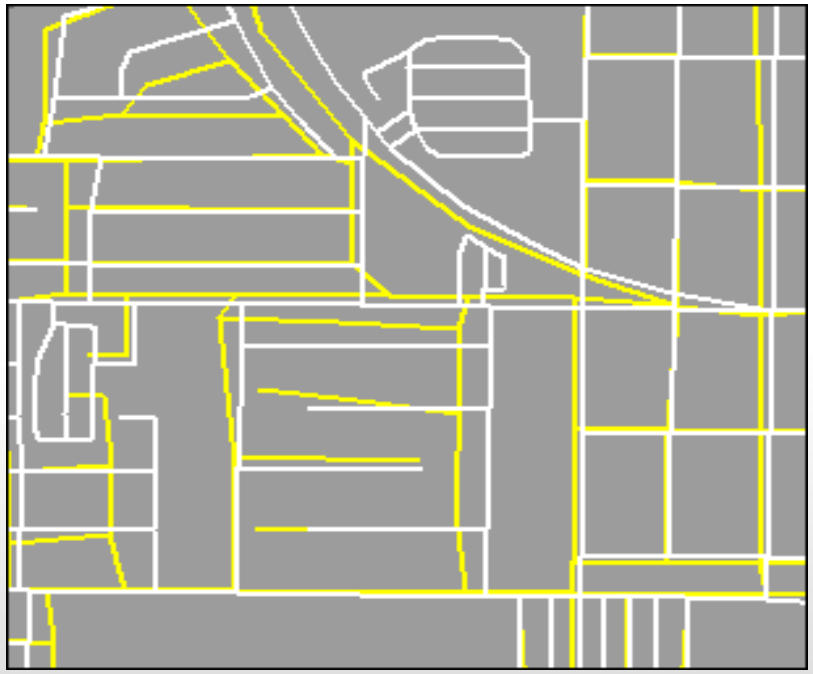
- Physical measurement error
- Mt. Everest is 8,850 +/- 5 m
- Dynamic earth makes stable measurements difficult
  - Seismic motion
  - Wobbling of Earth's axis
  - Wind and waves at sea!

Uncertainty in Measurement



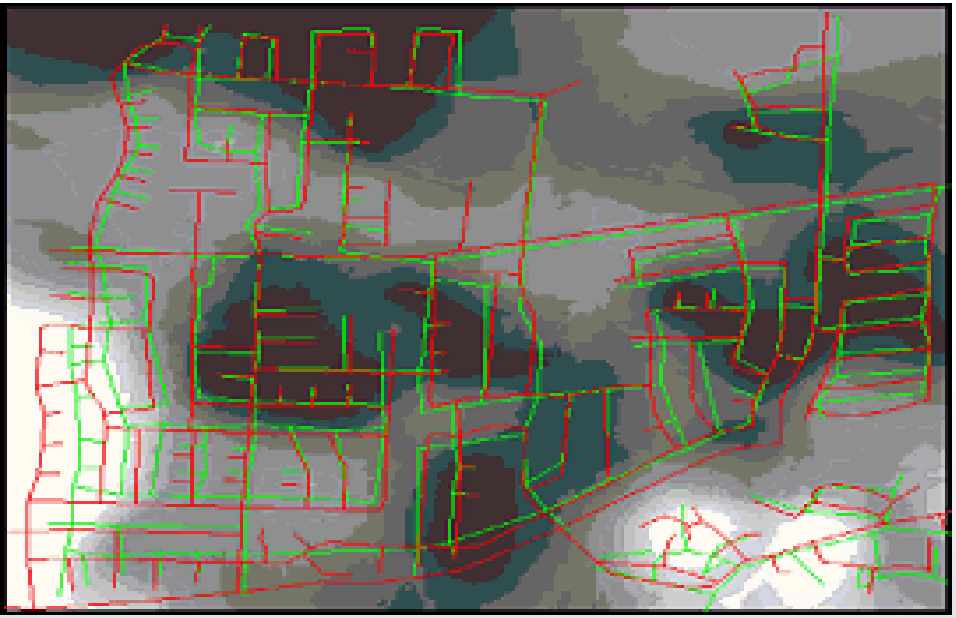
- Digitizing error, e.g.,
- Undershoots
- Overshoots
- “Gafs”

Uncertainty in Measurement



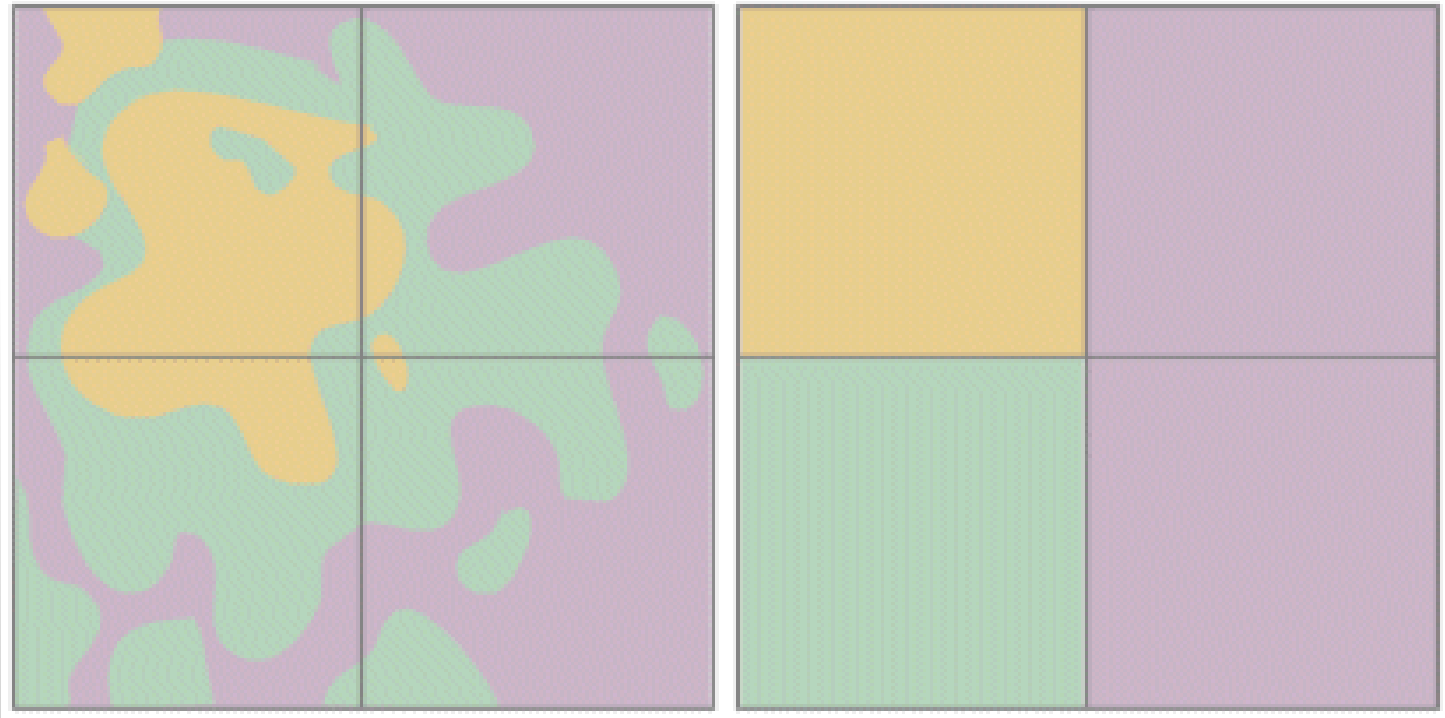
- Misalignment of data digitized from different maps
- *Rubbersheeting* is a corrective technique

Uncertainty in Measurement



- Different lineages of data
- Sample vs. population

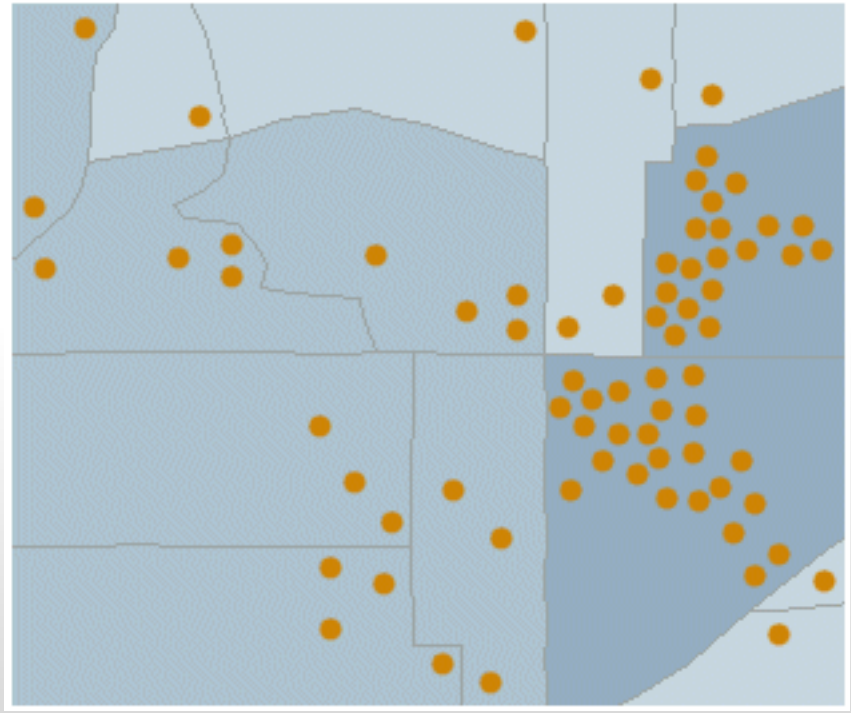
Uncertainty in Representation Raster Data Structure



mixels

Classification based on dominance, centrality?

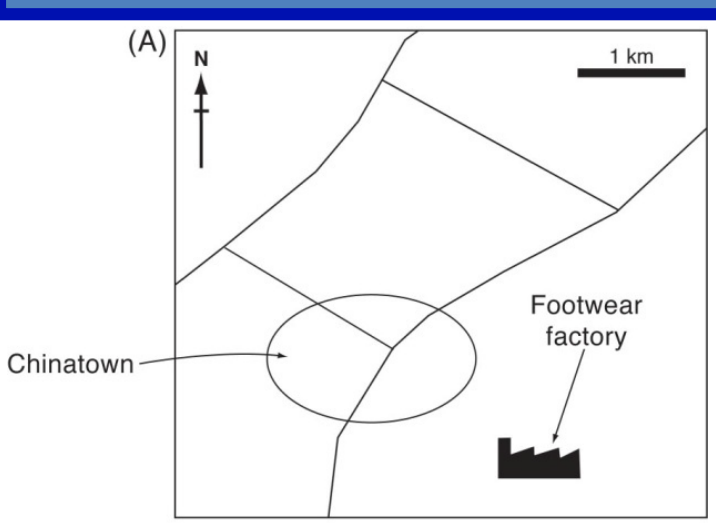
Uncertainty in Representation Vector Data Structure

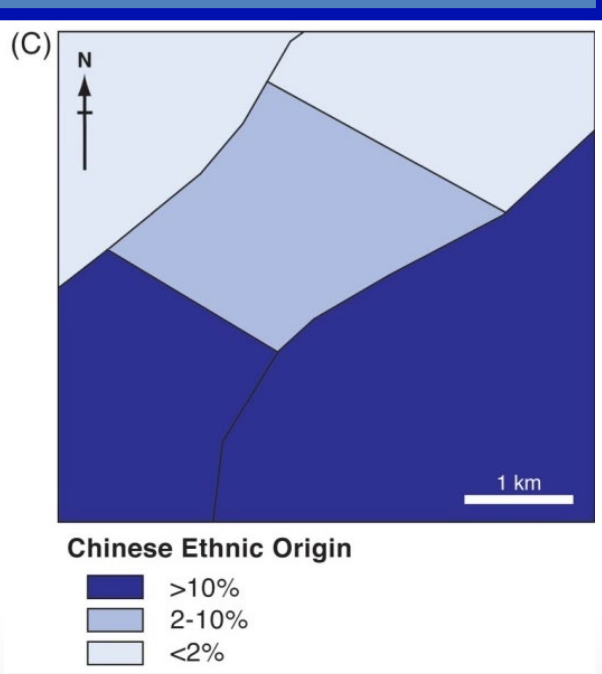


Points in corners of polys

Zones based on only a few points

Uncertainty in Analysis: The Ecological Fallacy

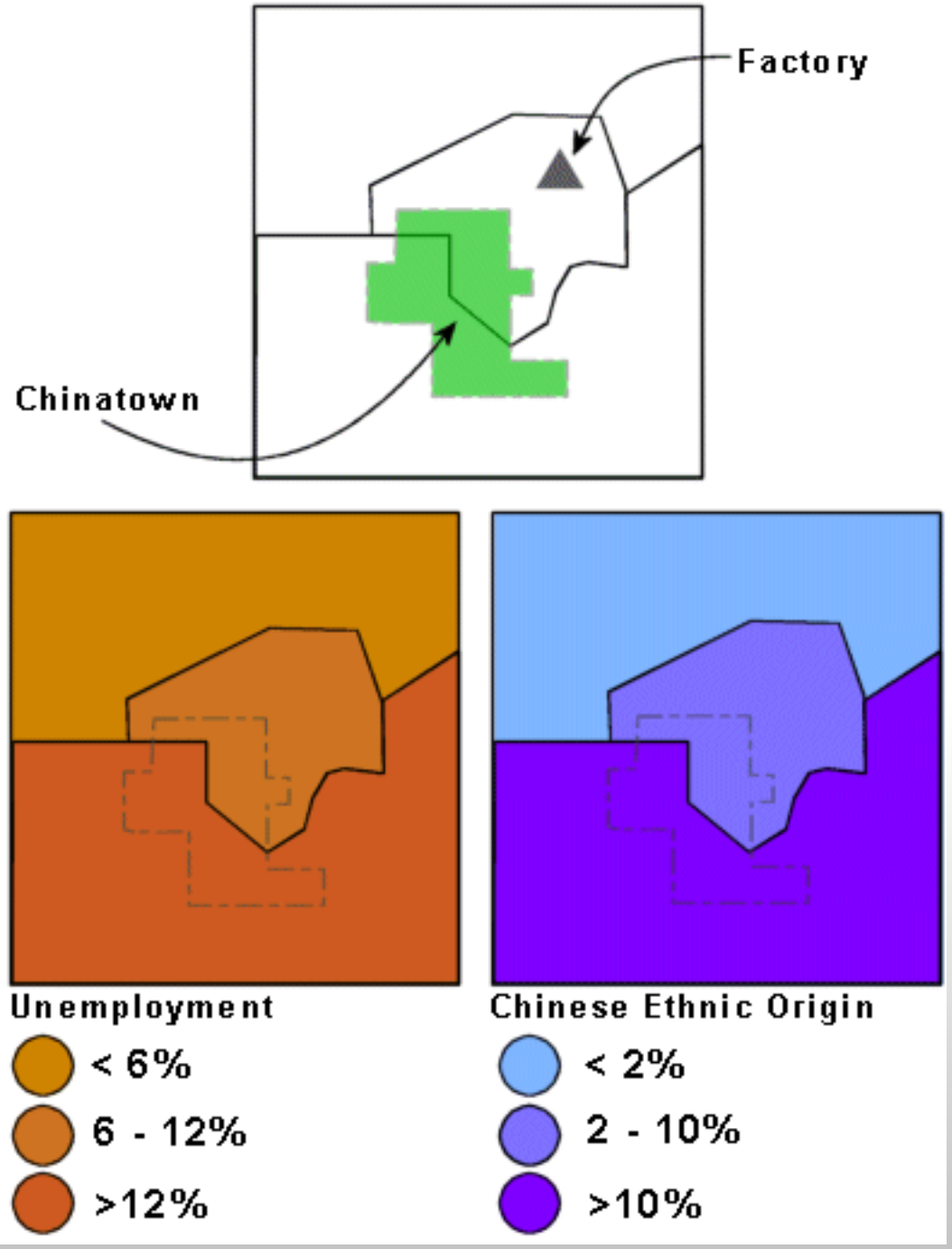




(A) Before it closed down, the footwear factory drew its labor from its local neighborhood and a jurisdiction to the west

(B) The closure caused high unemployment, but not among the service sector workers of Chinatown

(C) a spurious relationship between Chinese ethnicity and unemployment



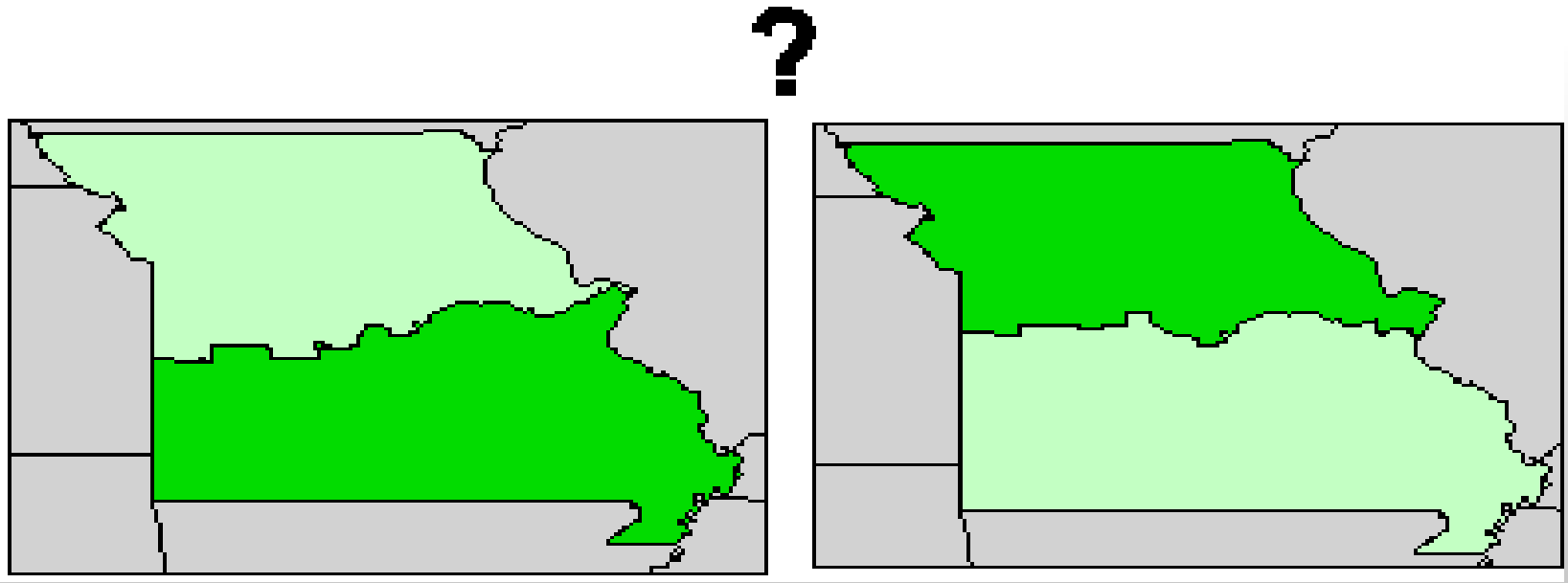
Uncertainty in Analysis Ecological Fallacy

an overall characteristic of a zone is also a characteristic of any location or individual within the zone

Factory w/no Chinese employees may have closed

Modifiable Areal Unit Problem (MAUP)

- number, sizes, and shapes of zones affect the results of analysis
- Many ways to combine small zones into big ones
- No objective criteria for choosing one over another



Path of boundary changes where high pop. is

Uncertainty of Geographic Phenomena

- **Conception** - spatial, vagueness, ambiguity, regionalization
- **Measurement** - field, digitizing, lineage
- **Representation** - raster, vector
- **Analysis** - ecological fallacy, MAUP

Thank you for your attention